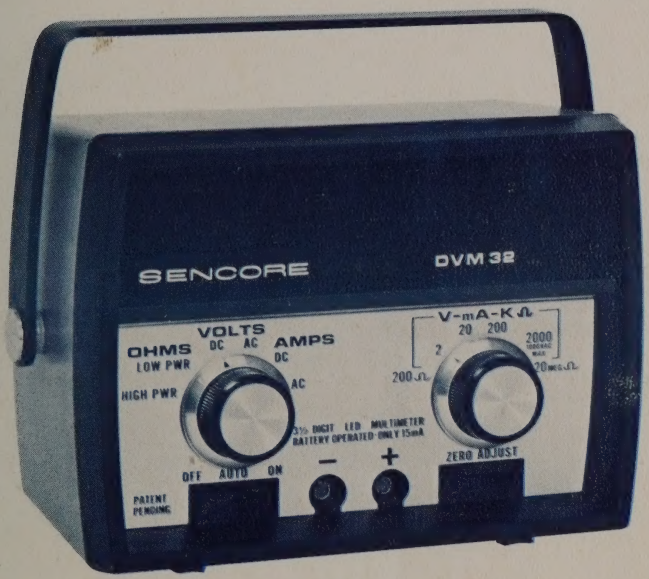
DVM32

DIGITAL MULTIMETER

SERVICE MANUAL



SENCORE

THE ALL AMERICAN LINE OF HIGH QUALITY TEST EQUIPMENT

FINAL PRODUCTION PROOF OF PERFORMANCE TEST

You have just purchased one of the finest portable DVM's on the market. Your unit has been thoroughly tested three times by our Production Department, and once more by our Quality Assurance Department after operating the unit for 24 hours.

Enclosed is a portion of the performance specs your unit displayed in its final testing. The calibration equipment used has accuracies traceable to the National Bureau of Standards to insure reliable calibration.

Please see the back of your Quality Assurance tag for the name of the person who performed these tests, and for details on the industry's most complete guarantee that backs this unit.

FUNCTION TESTED	PUBLISHED SPECIFICATION	TEST INPUT	MINIMUM ACCEPTABLE READING	MAXIMUM ACCEPTABLE READING	MEASURED READING
Hi Ohms	1%	10K	9.90	10.10	10.02
Lo Ohms	1%	10K	9.90	10.10	9.99
DCV	.5%	10V	9.95	10.05	9.98
ACV	1.5%	10V	9.85	10.15	9.95
DCC	1%	10mA	9.90	10.10	10.07
ACC	1.5%	10mA	9.85	10.15	10.04

SENCORE

Form 1108

FUNCTION TESTED	PUBLISHED SPECIFICATION	TEST INPUT	MINIMUM ACCEPTABLE READING	MAXIMUM ACCEPTABLE READING	MEASURED READING
Hi Ohms	1%	10K	9.90	10.10	
Lo Ohms	1%	10K	9.90	10.10	
DCV	1%	10V	9.95	10.05	
ACV	1.5%	10V	9.85	10.15	
DCC	1%	10mA	9.90	10.10	
ACC	1.5%	10mA	9.85	10.15	

DVM32
DIGITAL MULTIMETER

SCHEMATIC AND PARTS LISTS

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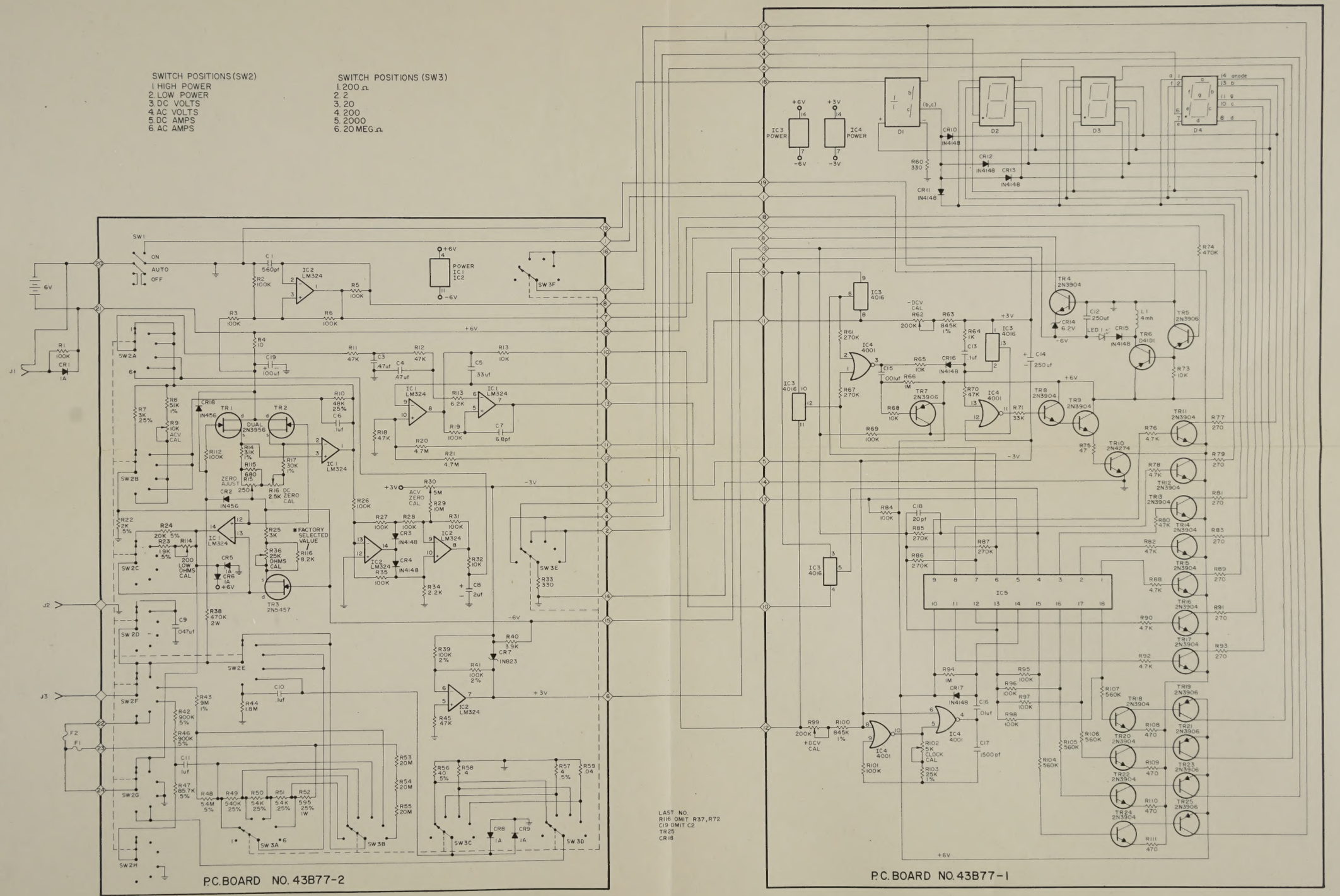
THE ALL AMERICAN LINE OF HIGH QUALITY TEST EQUIPMENT

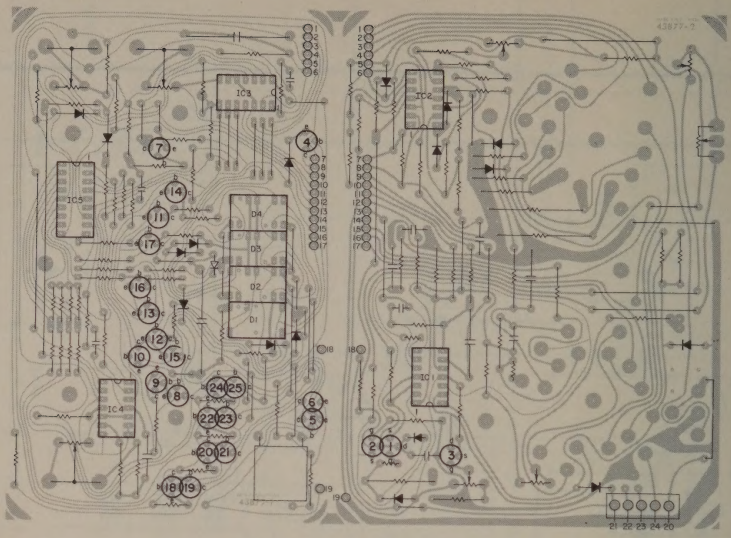
SWITCH POSITIONS (SW2)
1. HIGH POWER
2. LOW POWER
3. DC VOLTS
4. AC VOLTS
5. DC AMPS
6. AC AMPS

SWITCH POSITIONS (SW3)
1. 200 Ω
2. 2
3. 20
4. 200
5. 2000
6. 20 MEG Ω

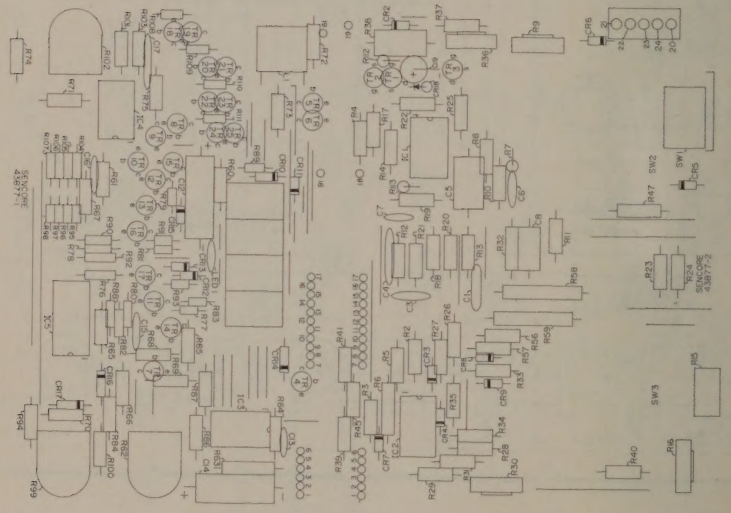


SCHEMATIC DIAGRAM DVM 32

ISSUE DATE: 6-19-75



Main P.C. Board - Foil Side View



Main P.C. Board - Component Side View

THE IDEA PEOPLE

SENCORE

3200 SENCORE DRIVE, SIOUX FALLS, SOUTH DAKOTA 57107

Form 1047

PRINTED IN U.S.A.

SAFETY REMINDERS

When testing electronic equipment, there is always a danger present. Unexpected high voltages can be present at unusual locations in defective equipment. The technician should become familiar with the device that he is working on and observe the following precautions.

1. When making test lead connections to high voltage points, remove the power. If this cannot be done, be sure to avoid contact with other equipment or metal objects. Place one hand in your pocket as a safety precaution and stand on an insulated floor to reduce the possibility of shock.

2. Discharge filter capacitors before connecting test leads to them. Capacitors can store a charge that could be dangerous to the technician.

3. Be sure your equipment is in good order. Broken or frayed test leads can be extremely dangerous and can expose the technician to dangerous potentials.

4. Remove the test leads immediately after the test has been completed to reduce the possibility of shock.

5. Do not work alone when working on hazardous circuits. Always have another person close by in case of accident. Remember, even a minor shock can be the cause of a more serious accident, such as falling against the equipment, or coming in contact with high voltages.

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THE IDEA PEOPLE

Main P.C. Board - Component Side View

Main P.C. Board - Foil Side View

DVM32
DIGITAL MULTIMETER

SCHEMATIC AND PARTS LISTS

SENCORE
THE ALL AMERICAN LINE OF HIGH QUALITY TEST EQUIPMENT

DVM32 PARTS LIST

SCHEMATIC REF. NO.	PART NO.	DESCRIPTION	PRICE
	110D326	Case, complete	9.00
	39G91	Probe and Test Lead Assy.	7.25
	143B77-1	PC Board Assy.	94.25
	143B77-2	PC Board Assy.	82.25
	8D130	Front Panel, Molded	2.00
	63K15	Filter Glass, Red	1.25
	11K41	Battery Clips	.25
	55A30	Battery Spring	.25
	21A50	Thumbwheel, Zero Adj.	.50
	21G66	Knob, Control	1.50
	10B327	Door, Battery Compartment	1.25
	8K132	Escutcheon, Front Panel	.50
CR1	16S10	Diode, Rectifier	.50
DIGITAL PC BOARD 43B77-1			
R63, 100	14C29-8455A	Resistor, 845K, 1%, ½W	.75
R103	14C29-2504A	Resistor, 25K 1%, ½W	.75
R102	15C7-16	Pot, 5K, PC Mtg.	.75
R62, 99	15C7-30	Pot, 200K, PC Mtg.	.50
TR4, 8, 9, 11-18, 20, 22, 24	19A33	Transistor 2N3904	.50
TR5, 7, 19, 21, 23, 25	19A34	Transistor 2N3906	.50
TR6	19A25	Transistor D41D1	1.25
TR10	19A18	Transistor 2N4274	.50
L.E.D. 1	20G14	Indicator, Single L.E.D.	1.00
DI 1	23G55	Display, ±1 L.E.D.	3.50
DI 2, 3, 4	23G54	Display, 7 segment L.E.D.	3.50
C13	24G216	Capacitor .1uF Mylar	.25
C17	24G191	Capacitor 1500 pf 5% Poly	.25
L1	46G64	Coil, 4mH, 10 ohm Max	.50
CR14	50C4-6	Diode, Zener, 6.2V 10%	.75
CR10 - 13, 15, 16, 17	50C5-2	Diode 1N4148	.25
IC3	69G11	IC 4016	1.25
IC4	69G7	IC 4001	2.00
IC5	69G14	IC AY - 5 - 3507	19.50

ANALOG PC BOARD 43B77-2

R7	14C27-3003A	Resistor 3K, .25% ½W	.75
R8	14C29-4804A	Resistor 48K, 1% ½W	.75
R10	14C27-4804A	Resistor 48K, .25% ½W	.75
R14	14C29-3504A	Resistor 35K, 1% ½W	.75
R17	14C29-3004A	Resistor 30K, 1% ½W	.75
R22, 24	14C28-2003A	Resistor 2K, .5% ½W	.75
R23	14C28-2004A	Resistor 20K, .5% ½W	.75
R25	14C29-1204A	Resistor 12K, 1% ½W	.75
R37	14C29-3905A	Resistor 390K, 1% ½W	.75
R39, 41	14C30-1005A	Resistor 100K, 2%, ½W	.75
R42, 46	14C28-9005A	Resistor 900K, .5% ½W	.75
R43	14C32-9006A	Resistor 9Meg, 1% 1W	1.25
R47	14C28-8574A	Resistor 85.7K .5% ½W	.75
R48	14C28-5406A	Resistor 5.4Meg, .5% ½W	.75
R49	14C27-5405A	Resistor 540K .25% ½W	.75
R50	14C27-5404A	Resistor 54K .25% ½W	.75
R51	14C27-5403A	Resistor 5.4K .25% ½W	.75
R52	14C33-5952A	Resistor 595 ohm .25% 1W	1.25
R56	14C28-4001A	Resistor, 40 ohm, .5% ½W	.75
R57	14C28-4000A	Resistor, 4 ohm, .5% ½W	.75
R9, 16	15C7-2	Pot, 10K, PC Mtg.	.50
R15	15A18	Control, 250 ohm	1.00
R30	15C7 - 7	Pot, 5Meg, PC Mtg.	.50
R36	15C7-13	Pot, 100K, PC Mtg.	.50
TR1, 2	19A31	Transistor, 2N3958, FET	4.00
TR3	19A27	Transistor, 2N5457, FET	1.50
C3, 4	24G222	Capacitor, .47uf 100V Poly	.75
C5	24G330	Capacitor, .33uf 5% Mylar	.75
C6, 10	24G216	Capacitor, .1uf Mylar	.25
C7	24G138	Capacitor, 6.8pf 10% NPO	.25
C9	24G255	Capacitor, .047uf 1KV Mylar	.50
C11	24G160	Capacitor, 1uf 10% Mylar	1.25
SW1	25A214	Switch, Rocker	1.50
SW2	25A219	Switch, Rotary, Function	7.25
SW3	25A220	Switch, Rotary, Range	7.25
CR2, 18	50C5-4	Diode, 1N456	.50
CR3, 4	50C5-2	Diode, 1N4148	.25
CR5, 6, 8, 9	16S10	Diode, Rectifier, 1A,400PIV	.50
CR7	50C12-1	Diode, 1N823, 6.2V Zener	1.50
IC1, 2	69G13	IC LM 324	4.50

Prices in effect at date of printing and are subject to change without notice.

When ordering parts, please specify model number, part number and description. Service and parts invoices are C.O.D. Please include remittance (check or money order) with your order to save C.O.D. charges. Minimum billing $3.00.

SAFETY REMINDERS

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3. Be sure your equipment is in good order. Broken or frayed test leads can be extremely dangerous and can expose the technician to dangerous potentials.

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Fig. 1 DVM32 Digital Multimeter

DESCRIPTION

INTRODUCTION

Our present day service market is marked by ever increasing demands for speed and accuracy in the equipment needed to accomplish the task of staying competitive and maintaining a fair profit margin. Recognizing these requirements, Sencore has designed the new DVM32 Digital Multimeter. The DVM32 incorporates the digital advantages of speed, accuracy and ease of reading and interpretation. There is also the additional advantage of more ruggedness because there is no delicate meter movement to be damaged by physical shock. The digital meter is more easily interpreted because there are no scales to become confusing and no parallax inaccuracies to take into account as with an analog meter. Accuracy is better with the digital meter because there is no mechanical interpretation of the values to be read which involves inaccuracy within the meter movement. These general features have created the demand for the digital meter that is now available in the Sencore DVM32.

FEATURES

* PORTABILITY: DVM32 operates on either battery power for portable use or optional AC line power for bench use.

* AUTO DISPLAY: This means longer battery life because in auto mode the L.E.D. display functions only when a measurement is being taken.

* LOW POWER OHMS: DVM32 has both HI and LO Power ohms for regular resistance measurements or in solid state circuits where LO Power is required to prevent erroneous readings.

SPECIFICATIONS

All accuracies expressed as percent of reading between 1/10 scale (200 reading) and full scale (1999 reading) $\pm$ 1 digit.

DC VOLTS:

4 Ranges: 0 to $\pm$1.999, $\pm$19.99, $\pm$199.9, $\pm$1999 volts
Accuracy: .5%
AC Rejection: 40db at 50-60Hz
Input Impedance: 15 megohms
Response Time: 1 second (worst case)
Input Protection: Protected to 2000V (DC + peak) on all ranges

AC VOLTS:

4 Ranges: 0 to 1.999, 19.99, 199.9, 1000 volts RMS
Accuracy: 1.5% at 60Hz between full scale and ¼ scale, 3% ±3 digits ¼ scale and 1/10 scale, ±1db 40Hz to 3KHz
Input Impedance: 1.8 megohms shunted by 18pf
Response Time: 2 seconds (worst case)
Input Protection: Protected to 1000V (RMS + DC) on all ranges

OHMS LOW POWER:

5 Ranges: 0 to 199.9 ohms, 1.999K, 19.99K, 199.9K, 1.999 megohms
Accuracy: 1%
Maximum Test Voltage: 80 millivolts
Response Time: 2 seconds (worst case)
Input Protection: Protected to 1000 volts (DC + peak) on all ranges

OHMS HIGH POWER:

5 Ranges: 0 to 1.999K, 19.99K, 199.9K, 1.999 megohms, 19.99 megohms
Accuracy: 1% on all ranges except 5% on 19.99 megohms
Maximum Test Voltage: 800 millivolts
Response Time: 2 seconds (worst case)
Input Protection: Protected to 1000 volts (DC + peak) on all ranges

DC CURRENT:

4 Ranges: 0 to ± 1.999, ± 19.99, ± 199.9, ± 1999 milliamps
Accuracy: 1%
Response Time: 1 second (worst case)
Internal Protection: 2 amp diode protection in series with 2 amp fuse

AC CURRENT:

4 Ranges: 0 to 1.999, 19.99, 199.9, 1999 milliamps
Accuracy: Same as AC volts
Response Time: 2 seconds (worst case)
Internal Voltage Drop: 80 millivolts RMS full scale
Input Protection: 2 amp diode protection in series with 2 amp fuse

GENERAL

AUTO DISPLAY: Display automatically actuated with readout of 010 or greater, blank otherwise (except on OHMS) for minimum current drain (only

15mA) and elimination of zero blinking condition. Permanent display available using "ON" position.

AUTO POLARITY: Automatic "+" or "—" on DC volts and DC Current. No indication on ohms, AC volts or AC current.

AUTO DECIMAL: Automatic decimal placement for each range.

AUTO OVERRANGE INDICATION: Readout of 1000 with blinking 1.

POWER REQUIREMENTS: Three options available:

1. Battery operation: Four standard 1.5 volt "C" cells.

2. 105-130 volts, 50-60Hz AC, using optional auxillary 115/230VAC Power Adaptor (Sencore part no. 39G90) with four standard "C" cells for filtering.

3. Rechargeable Battery Operation: 105-130 volts, 50-60Hz AC using optional auxillary 115/230VAC Power Adaptor (Sencore part no. 39G90) used with four rechargeable "C" cells (Burgess no. CD14 or equivalent.)

CURRENT DRAIN: 15mA with unit in AUTO position and displays blanked, up to 100mA maximum during measurement in AUTO or in ON position.

READOUT: .3 inch L.E.D., seven segment.

FUSES: One 3AG, 1/16 amp fast blow for volts and ohms protection.
One 3AG, 2 amp fast blow for current protection. (Two each supplied with unit.)

PILOT LIGHT: Single L.E.D. display indicates unit is on. Draws no extra current to drain batteries.

MECHANICAL DESCRIPTION: Virtually indestructible Cycolac® case with black anodized aluminum handle that doubles as tilt bail for bench use.

SIZE:	Width: 7" (17.78cm) Heighth: 5" (12.70cm) Depth: 4" (10.16cm)
WEIGHT:	2¼ lbs. (1.01Kg) including batteries.
PROBES:	(39G91) Direct Input Probe with 200K Isolation position. (Supplied with unit.) (39G92) High Voltage Probe extends 2000 volt range to 50KV. (Not supplied with unit.)

CONTROLS AND FEATURES

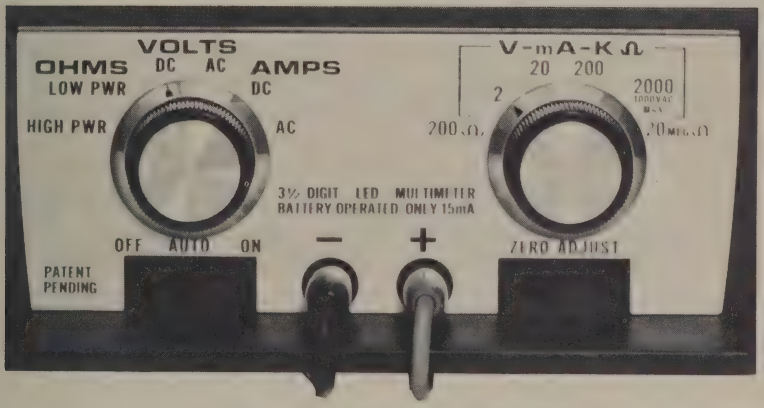

Fig. 2 DVM32 Front Panel

OFF-AUTO-ON: Auto position of this switch applies power to the instrument but does not allow the display to light, except in OHMS function, until a voltage or current reading of 10 or greater is obtained. This provides longer battery life by reducing current drain by 70% until a measurement is made. In ON position the display will be on at all times.

OHMS-VOLTS-AMPS: This function switch selects either HI or LO power ohms, DC or AC volts or DC or AC current.

V-mA-K: This range switch selects the range of voltage, current or ohms required for the measurement being made and automatically positions the decimal.

ZERO ADJUST: This control is used for zeroing the meter display in the DC volts function with any voltage range selected.

(—) JACK: This is the common jack. The black lead installed in this jack should be connected to the ground or low potential point of the circuit being measured.

(+) JACK: This is the "HOT" input jack. The probe lead installed in this jack should be connected to the high potential point of the circuit being measured.

AUTO POLARITY: This feature provides automatic "+" or "—" indication on DC volts and current. There is no polarity indication on AC volts, AC current or ohms functions.

AUTO OVERRANGE: Overrange is indicated on all functions by a reading of 1000 with the 1 blinking.

ISOLATION PROBE: Test probe (39G91 supplied) has a selectable 200K isolation resistor switch position. This position may be used when measuring DC voltages in high frequency circuits to prevent erroneous readings.

HI VOLTAGE PROBE: HV probe (39G92 optional) extends the 2000 volts measurement range to 50KV. The 200 volt range can be used for measurements of voltages less than 20,000 volts. This probe plugs onto the tip of the test probe supplied.

AC ADAPTOR: This adaptor (39G90) is optional and provides for operating the DVM32 on 105-130VAC, 50-60Hz line power. This adaptor must be used with 4 standard "C" cells for filtering or with 4 rechargeable "C" cells. (Burgess CD14 or equivalent.)

OPERATION

INSTALLING BATTERIES

1. Remove the battery compartment cover by loosening the knurled thumb screw.

2. Install 4 "C" cell batteries with positive ends to the right.

3. Replace the cover and tighten the thumb screw.

NOTE: If batteries are installed backward, no damage to the instrument will result because the batteries will not make connection.

PREPARING FOR MEASUREMENT

1. Place the OFF-AUTO-ON switch in the ON position, set the Function Switch to VOLTS DC position and the Range Switch to any voltage range.

2. Adjust the ZERO ADJUST control for three zero display with the "+" and "—" alternately displayed. The third digit may flash between 0 and 1.

3. Set the Function Switch to one of the OHMS functions and note the overrange indication of 1000 with the "1" blinking. Shorting the test leads together will produce a zero reading with the probe isolation switch in the NORM position.

AUTO DISPLAY

The AUTO position of the OFF-AUTO-ON switch may be used during voltage or current measurements to avoid excessive drain on the batteries. The display L.E.D.s will be off until a measurement exceeding a reading of 010 is present at which time the readout display will automatically come on. This feature allows a drain of only 15mA from the batteries until a measurement is being made, at which time, the current drain will be approximately 100mA.

Remember, as you continue through the operation instructions, that AUTO mode may be used at any time. Low value readings of less than 010 will require that the ON position be used to obtain a display. ON position must also be used for zeroing the instrument.

DC VOLTAGE MEASUREMENT

1. Set the Function Switch to the VOLTS DC position. Make sure the probe isolation switch is in the NORM position, unless the isolation resistor is needed for isolation in high frequency circuits.

2. Zero the instrument as explained in PREPARING FOR MEASUREMENT step.

3. Set the Range Switch as required for the voltage to be measured. If the amplitude of the voltage is unknown, start with the highest range and work down to the range required for a satisfactory reading.

4. Connect the common lead to the ground or common point of the circuit in which measurements are to be made.

5. Touch the test probe to the voltage point to be measured. The instrument will determine the polarity and indicate either "+" or "—", and the voltage measured. If the voltage is over the range selected the overrange indication of 1000 with "1" blinking will be displayed.

AC VOLTAGE MEASUREMENT

1. Set the Function Switch to the VOLTS AC position.

2. Be sure the probe isolation switch is in the NORM position.

3. Set the Range Switch to the desired voltage range or start with the highest range and work down until the desired readout is obtained.

NOTE: There will be no polarity indication when measuring AC volts.

DC CURRENT MEASUREMENT

1. Set the Function Switch to the AMPS DC position.

2. Set the Probe Switch to the NORM position.

3. Set the Range Switch to the proper current position. If the current to be measured is unknown start with the highest range.

4. Before connecting the instrument to read current always REMOVE power from the equipment in which the current is to be measured.

5. To measure current always connect the meter leads in series with the circuit. Break the circuit between the power source and the load and connect the test leads to each terminal of the open circuit. Auto polarity circuitry in the instrument will indicate either "+" or "—" current depending upon which way the leads are connected.

AC CURRENT MEASUREMENT

1. Set the Function Switch to the AMPS AC position.

2. Set the Probe Switch to the NORM position.

3. Set the Range Switch to the proper current range. If in doubt about the value of current to be measured, use the highest range and work down to obtain a satisfactory reading.

4. Proceed with connections as explained in DC CURRENT MEASUREMENT steps 4 and 5.

NOTE: There will be no polarity indication when measuring AC current.

RESISTANCE MEASUREMENTS

1. Set the Function switch to OHMS LOW POWER if measurements are to be made in solid state circuits. OHMS HIGH POWER or OHMS LOW POWER may be used for normal resistance measurements.

2. Set the Probe Isolation Switch to NORM position.

3. Set the Range Switch to the desired position.

4. REMOVE POWER from the equipment in which the measurement is to be taken and DISCHARGE electrolytic capacitors.

5. Connect the test leads across the resistance to be measured. If the resistance value exceeds the range selected the overrange indication of 1000 with the "1" blinking, will be present.

DC VOLTAGE MEASUREMENTS WITH ISOLATION

The 39G91 probe supplied with the DVM32 is designed with a selectable 200K isolation resistor to isolate the input capacity of the DVM32 from critical circuitry such as RF, IF or Sweep circuits when making DC voltage measurements in these circuits. Voltage measurement taken in these circuits, without the use of the isolation resistor, may be erroneous and misleading. Use of the probe isolation resistor will eliminate this large error but will introduce an error in the reading that may be up to 1.3% low. Isolation should only be used when the NORM position results in an erroneous reading. This will maintain accuracy of the instrument readings when isolation is not needed.

When isolation is required or desired simply place the Probe Switch in the 200K ISOLATION position and proceed as described in the DC VOLTAGE MEASUREMENT section.

DC VOLTAGE MEASUREMENTS OVER 2000 VOLTS

NOTE: READ THIS SECTION ENTIRELY BEFORE PROCEEDING WITH TEST!

To measure DC voltages over 2000 volts the 50KV probe (39G92) must be used. This probe is available from your nearest Sencore Distributor. To accomplish this measurement proceed as follows:

1. Install the supplied probe by plugging the banana plug into the DVM32 (+) JACK VERY SECURELY.

2. Install the 50KV probe (39G92) by plugging the test probe into the back of the high voltage probe.

3. Set the Function Switch to VOLTS DC and the Range Switch to 2000V position.

4. Zero the instrument as described in PREPARING FOR MEASUREMENT section.

5. REMOVE POWER from the equipment in which high voltage is to be measured.

6. SECURELY ATTACH the black common lead from the DVM32 to the ground, chassis or common point of the high voltage circuit to be measured, so that this lead cannot become detached during the high voltage measurement.

7. Connect the high voltage probe to the high voltage point to be measured, so that the probe DOES NOT have to be held in the hand during the high voltage measurement.

CAUTION! IF the probe MUST be held on the high voltage point during measurement, be sure to keep one hand in your pocket and your feet on dry, insulated material. Hold the probe by the BLACK, handle portion of the probe ONLY!

8. Apply power to the equipment in which the high voltage to be measured is present.

9. Multiply the reading on the instrument by 100 to obtain the value of the voltage being measured.

EXAMPLE: If the reading on the instrument is 300, multiply 300 X 100 for the value of 30,000 volts being measured, or simply add 2 zeros to your reading.

10. REMOVE POWER from the equipment being measured and detach the high voltage probe and common lead.

NOTE OF CAUTION! If the common lead becomes detached during the measurement of high voltage, a SEVERE SHOCK HAZARD WILL be present. DO NOT TOUCH the DVM32 or the high voltage probe, but immediately REMOVE POWER from the equipment in which the high voltage is being measured. Then remove the high voltage probe from the equipment. Under this circumstance, damage to the DVM32 may also have resulted, especially if the instrument is being operated on AC line power. Should the high voltage probe banana plug become

disconnected from the DVM32 (+) jack during high voltage measurement, DO NOT TOUCH the probe lead or banana plug. Immediately REMOVE POWER from the equipment in which the high voltage is present, disconnect the high voltage probe from the equipment, then reconnect the probe banana plug to the DVM32 (+) jack.

CONNECTING COMMON ABOVE GROUND

When operating the DVM32 on battery power only, the common lead may be connected to a potential of up to 1000 volts (DC plus peak). For the safety of the operator this value should not be exceeded.

When operating the instrument using the AC Power Adaptor (39G90), the common lead may be connected to a potential of up to 1000 volts (DC plus peak). This value must not be exceeded to avoid exceeding the insulation rating within the AC Power Adaptor.

OVERLOAD PROTECTION

Your DVM32 is protected against accidental overloads on all functions and ranges. The voltage ranges are protected by high input impedance and diode protection on the gate of the input buffer amplifier FET. Further protection is provided by fuse F1, (1/16 amp) for extreme voltage overloads. The ohms functions are also protected by F1 to prevent damage to internal resistors and circuitry. The current functions are protected by fuse F2, (2 amp). Both fuses should be replaced with ones of the same type so the protection feature and accuracy of the DVM32 are not affected.

FUSE REPLACEMENT

A quick check for fuse F1, is to select the HI OHMS function and the 2000K range. Short the common lead to the test probe and set the probe isolation switch to 200K ISOLATION position. If the instrument reads approximately 200 the fuse is good. If not, remove the battery cover and check the fuse (left hand fuse). When the fuse is bad, it should be replaced with a 3AG 1/16 amp fuse. Do not use a slow blow fuse as inaccuracy and possible damage to the instrument may result.

If current measurements result in a zero reading fuse F2 may be blown. Remove the battery cover and check the fuse (right hand fuse). When the fuse is bad, replace it with a 3AG 2 amp fuse. Do not use a slow blow fuse as damage to the instrument may result.

One spare fuse of each type required is supplied with the DVM32. They are located in the case recess hole right above the fuse holders, behind the battery cover.

BATTERY CHECK

The batteries powering the DVM32 may be easily checked using the instrument itself. Use the following procedure:

1. Select the VOLTS DC function and the 20V range.

2. Touch the probe tip to the AC adaptor jack pin located at the bottom rear of the unit. The readout will be the battery voltage.

If the battery voltage is below 4.8 volts the accuracy of the instrument will be seriously affected. The batteries should then be replaced.

CHECKING DIODES

Diodes and transistor junctions may be checked for front to back ratio using the DVM32. Also, whether a diode is of the germanium or silicon variety may be determined easily. Use the following procedure for either diodes or transistor junctions:

1. Set the DVM32 to OHMS HI POWER and select the 2K range.

2. Connect the black common lead to the cathode of the diode and the probe to the anode.

The reading for a good silicon diode should be over .800 (normally 1.000 to 1.600). The reading for a good germanium diode should be less than .800 (normally .400 to .600).

3. Reverse the connections on the diode placing the black common lead on the anode of the diode.

4. Select the 2000K range. A good silicon diode should indicate an overrange condition of 1000 with the "1" blinking. A good germanium diode may indicate some small reading on the 2000K range but should show an overrange indication on the 20K range.

AC LINE OPERATION

The DVM32 may be operated from 105-130VAC 50-60Hz line power, if desired, by using the optional AC Power Adaptor, 39G90, which is available from your nearest Sencore Distributor.

This adaptor plugs into the jack provided at the rear of the instrument. However, the adaptor MUST be used with standard "C" cell batteries installed OR with rechargeable "C" cells installed. (Rechargeable - Burgess No. CD14 or equivalent.) The batteries are required to provide ripple filtering of the voltage from the AC power adaptor.

CIRCUIT DESCRIPTION

1. Power Supply
2. Voltage Divider and Buffer Amplifier
3. AC to DC Converter
4. Ohms Converter
5. Current Function Circuit
6. Analog to Digital Converter
7. Digital Readout Circuitry
8. Auto Display Circuit

POWER SUPPLY

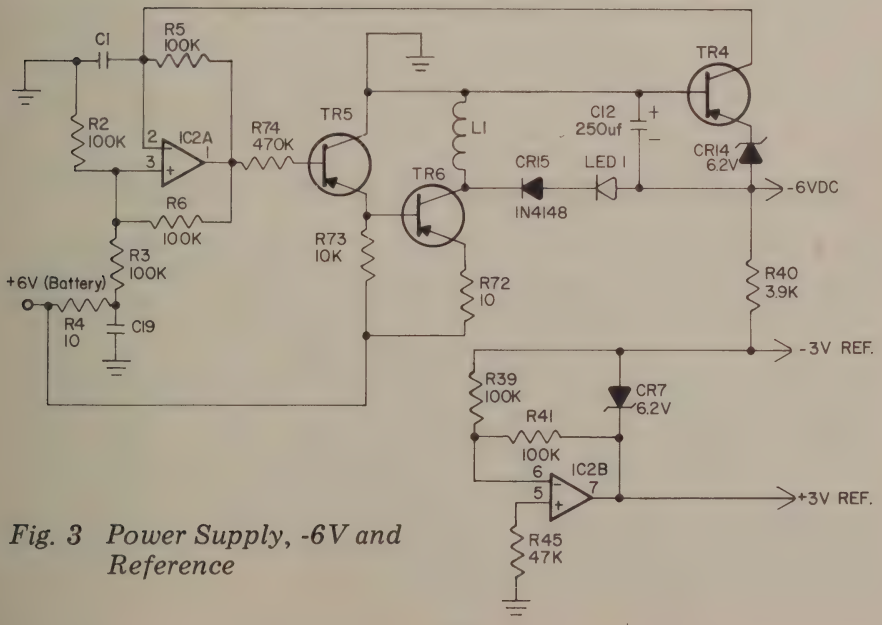

Fig. 3 Power Supply, -6V and Reference

The primary power supply of the DVM32 consists of four "C" cells. The positive terminal of the series battery combination supplies the positive voltage for IC1, IC2, IC3, IC5 and all transistors. The negative terminal is circuit ground.

A negative 6VDC supply is required by IC1, 2, 3 and 5. This voltage is generated by a zener regulated switching type power supply. IC2A and its associated circuitry comprise an oscillator. The negative pulse from this oscillator drives coil L1 into saturation by means of current amplification through TR5 and TR6. After the negative pulse, TR5 switches the current through L1 off. This creates the reverse EMF across L1, which is rectified by CR15 and L.E.D. 1, filtered by C12 and regulated by CR14 and TR4. The oscillator output will remain in a quiescent high state, due to feedback from TR4 collector, until the magnitude of the negative voltage is less than the regulated amount. At that time TR4 feedback is removed from the oscillator and another negative pulse is produced, causing the process to be repeated. Thus, the frequency of the oscillator increases as the load on the - 6 volt supply increases.

IC2B is used in conjunction with CR7 to provide reference voltages. Positive and negative 3.1 volt reference voltages are generated by means of a temperature compensated 6.2 volt regulator diode, CR7. The operational amplifier, IC2B, output is initially at zero. When the negative voltage is applied, across R39, the output rises positive. CR7 will then regulate the reference voltages at positive and negative 3.1 volts.

VOLTAGE DIVIDER AND BUFFER AMPLIFIER

The front end of the DVM32 utilizes a buffer amplifier consisting of TR1, TR2 and IC1A operational amplifier. In the VOLTS functions the gain of IC1A is set at 25 by R10 and R22 biasing the gate of TR2.

Assume that we have applied a positive 1.000 voltage between the input and common jack of the instrument. The voltage is applied across the voltage divider consisting of R43 - R52. The 2 volt range has been selected. The voltage tapped off at junction of R48 and R49 is 40mV. This voltage is applied to the gate of TR1. TR1 source transfers this voltage to the pin 3 input of IC1A. The output of IC1A is then 1.000 volt DC which is coupled to the comparator in the analog to digital converter circuit.

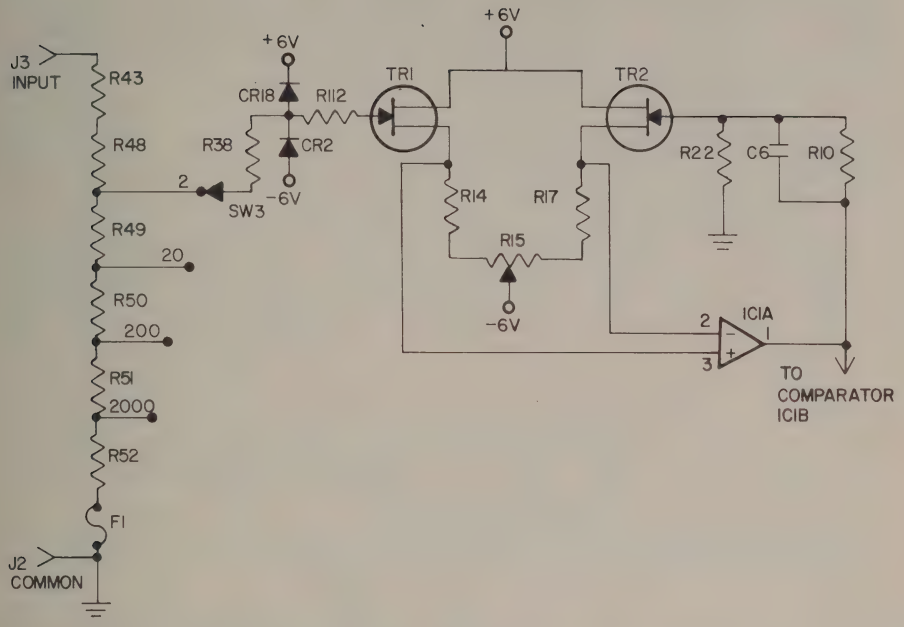

Fig. 4 Voltage Divider and Buffer Amplifier

AC TO DC CONVERTER

Assume now that we have selected the VOLTS AC function and 2V range. We apply a 1.000 VAC RMS voltage between the input and common jacks. The output of the buffer IC1A will now be 1.000 VAC RMS and this signal will be applied to pin 13 of IC2B. (Refer to Fig. 5). IC2D, C has a gain of 1 and thus the output of IC2D

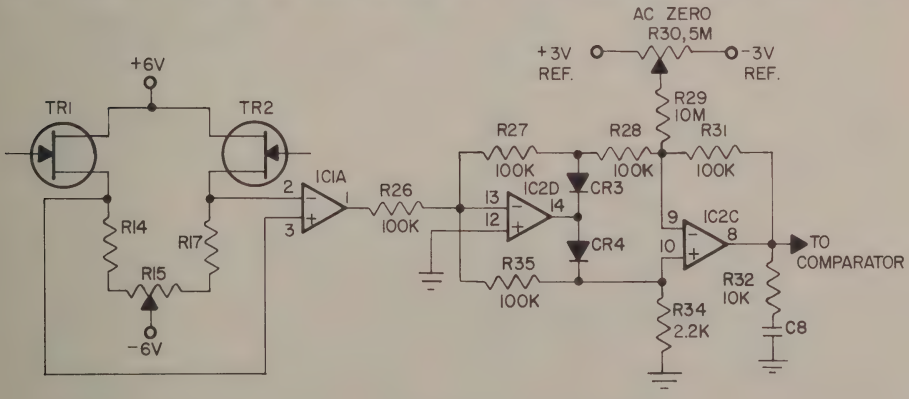

Fig. 5 AC to DC Converter

is 1 volt RMS, which is rectified by CR3 and CR4 and applied alternately to inputs 9 and 10 of IC2C. The output of IC2C pin 8 is 1.000 VDC which is applied to the comparator. In this manner the AC input voltage is converted to DC so that it may be processed by the analog to digital converter.

OHMS CONVERTER CIRCUIT

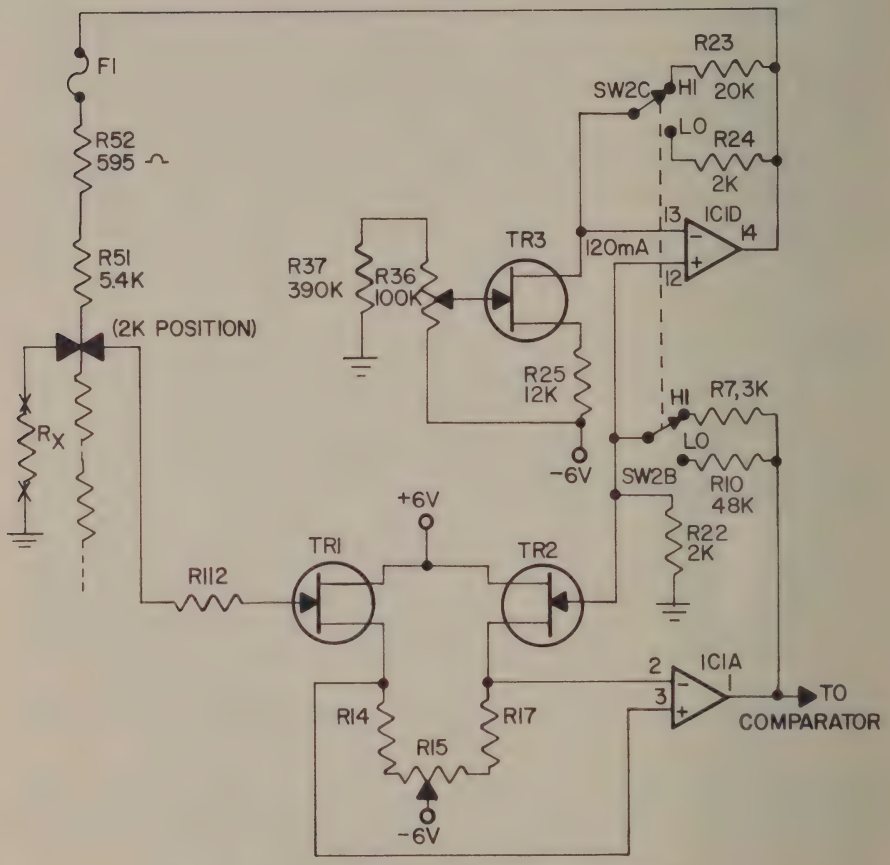

Fig. 6 Ohms Converter Simplified

The ohms converter generates a constant current through an unknown resistor and the voltage developed across the unknown resistor is then read directly as a normal DC voltage.

TR3 and R25 form 120 microamps constant current source which is coupled into the input of IC1D (pin 13). This forces the output of IC1D (pin 14) to be .24 volts (LO POWER) or 2.4 volts (HI POWER) above pin 12 of IC1D and consequently above the gates of TR1 and

TR2 by the same value. Thus, the voltage across R51 and R52 is constantly .24 volts or 2.4 volts depending upon whether Lo power or Hi power ohms function is used.

Now assume we wish to measure a 1K resistor using Lo power ohms. The 2K range is selected. The output of IC1D is coupled through F1, R52 and R51 (total of 6K) to the probe and the buffer input gate of TR1. Since the voltage across this 6K resistance is held at a constant .24 volts the current will be fixed at 40 microamps through the unknown (Rx) resistor. For this 1K resistor we are measuring, this current will yield 40mV DC into the input buffer amp, TR1 gate. The output of IC1A will be 1.000 volt which is fed to the comparator and will supply a readout of "1.000" which equals 1K on the 2K range.

Accuracy of the ohms functions depend upon DC voltage calibration as well as ohms calibration. DC voltage calibration should always be done before ohms calibration.

Anytime VDC calibration is adjusted the ohms calibration should also be checked, and adjusted if necessary. (See Calibration section.)

CURRENT FUNCTION CIRCUIT

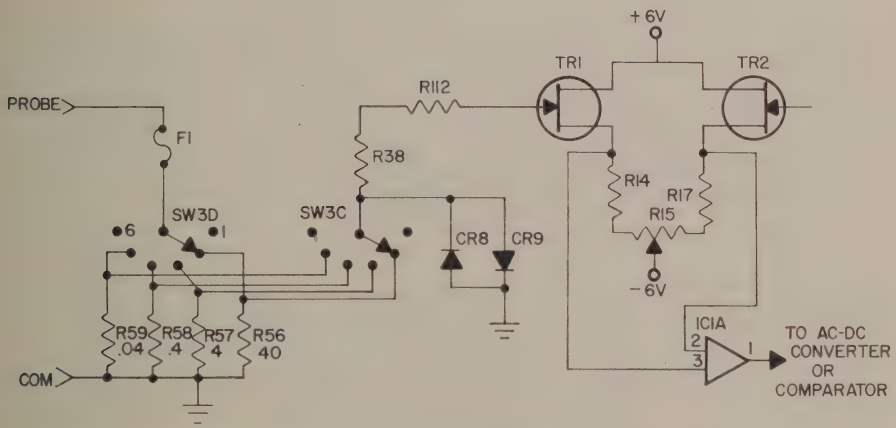

Fig. 7 Current Function Circuit Simplified

Current measurements are accomplished by passing the unknown current through a shunt resistor and measuring the voltage generated across the shunt resistors.

For example, let us measure a current of 1mADC. The current passes from the probe through F1, SW3D and R56 (2mA position) to the common lead. The voltage produced across R56 (40 ohms) is 40mV. This voltage is coupled through SW3C, R38 and R112 to the gate of the buffer input amplifier, TR1. The output of the buffer amplifier, IC1A, will be 1.000 volt DC. This voltage is fed to the analog to digital converter where it is processed to supply a readout of "1.000" on the display.

When measuring AC current the same process takes place except one more step is included. The output of the buffer amplifier is fed to the AC to DC converter where the AC voltage is converted to DC voltage to be processed by the analog to digital converter.

ANALOG TO DIGITAL CONVERTER

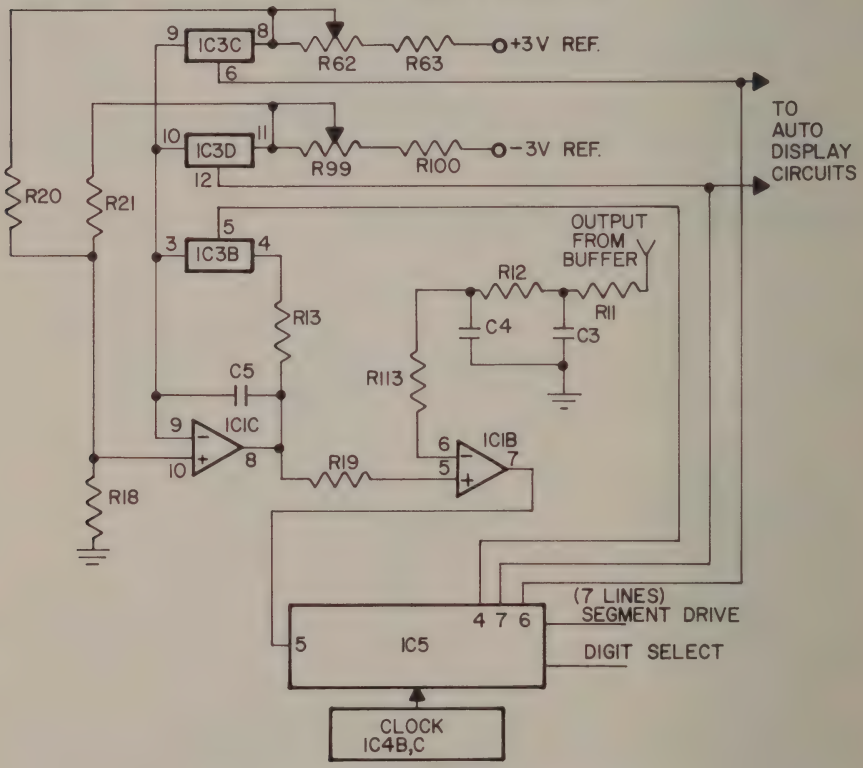

Fig. 8 Analog to Digital Converter

The analog to digital converter consists of a comparator made up of IC1B and IC1C, LSI logic and counter chip IC5, and a system clock consisting of IC4B, IC4C and associated components.

The clock is a simple CMOS oscillator which produces a 10KHz square wave used to time the counting circuitry in IC5.

Assume we are measuring 1.000VDC at the input of the instrument. The output of IC1A will be +1.000 volts DC. This positive output is coupled to the comparator negative input pin 6 of IC1B producing a negative comparator output of pin 7 fed to pin 5 of IC5.

The counting circuitry of IC5 counts clock pulses until it reaches a count of 2000. When the count of 2000 is reached, the counters are reset and the negative comparator output is detected. Logic circuits in IC5 then produce a logic HI at pin 7 which closes the analog switch IC3D. This drives a negative current from the -3VREF source into the negative input, pin 9, of IC1C, causing the integrator to generate a positive going ramp at IC1C pin 8. This ramp continues until the amplitude of the ramp at IC1B pin 5 equals the comparator input voltage at pin 6, at which time the output of IC1B pin 7 will switch to a positive voltage. This positive voltage at IC5 pin 5 causes the IC5 digit driver circuitry to store and display the number of clock pulses counted since the counter reset. The counters in IC5 will, however, keep counting clock pulses until the count of 2000 is reached, at which time a logic HI at pin 4 of IC5 will close the analog switch IC3B. This discharges C5 and makes it ready for the next ramp cycle which begins at the next count of 2000 clock pulses.

We see then, that there are two parts to the analog to digital converter cycle. One part is a measure cycle, during which time the ramp is generated until the comparator toggles and count is stored. The other part is a zero cycle during which time integrator is discharged and readied for the next measure cycle. Each part is 2000 clock pulses, or 200 milliseconds long. Total cycle time is therefore 400 milliseconds or 2½ measurements per second.

If the input voltage being measured were negative the positive comparator output signal at pin 5 of IC5 would cause IC5 to produce a logic HI at pin 6. This closes analog switch IC3C and the integrator would generate a negative ramp. The proper polarity display is determined by IC5.

DIGITAL READOUT CIRCUITRY

The LSI chip, IC5, contains all of the display logic circuitry to provide outputs to the proper segment cathodes and multiplexed digit driver outputs to select the proper segments of the proper display to give the required readout, according to the number of counts stored.

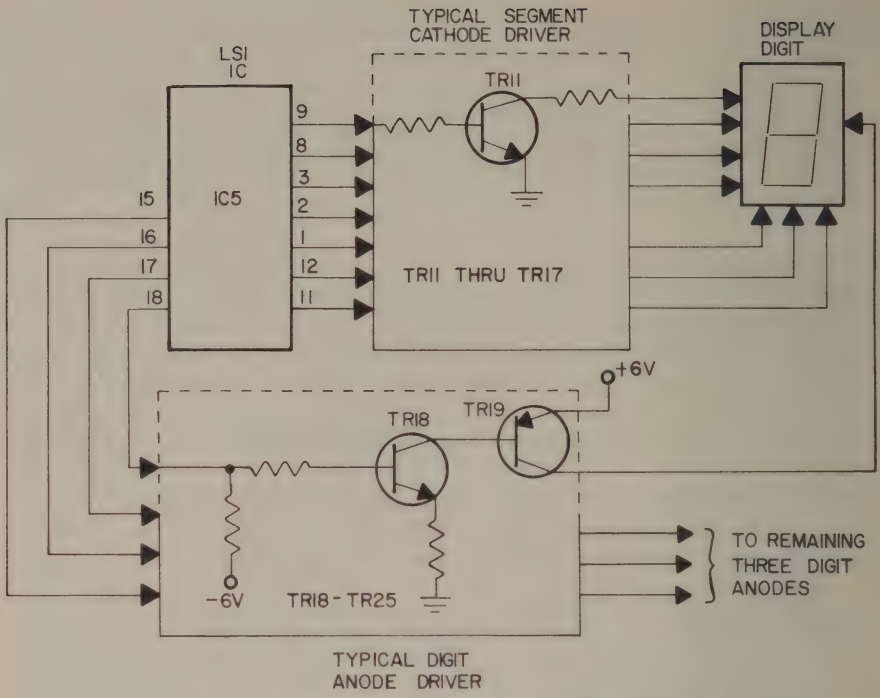

Fig. 9 Digital Readout Circuitry Simplified

Let us assume the first digit to be displayed is a "1", for example. IC5 pin 18 would supply a logic HI which energizes anode drivers TR18 and TR19 providing +6VDC at the anode of the first display digit. At the same time logic HI's are provided at IC5 pins 9 and 11 placing a ground on the "b" and "c" segments cathodes through TR11 and TR17. This will cause current to flow through segments "b" and "c" of the first display digit giving a "1" display. IC5 pin 18 now goes to logic LOW and pin 17 to logic HI, energizing the second display digit anode. If a "1" was to be displayed as the next digit, pins 9 and 11 would remain at logic HI and the "1" would be displayed.

Each digit is displayed seperately while the others are off but the total display is repeated 1000 times per second, creating the illusion that all digits are on at the same time.

AUTO DISPLAY CIRCUIT

Transistor TR10 provides the only source for grounding the display segment cathodes when the AUTO position of the OFF-AUTO-ON switch is used. Therefore, there can be no display until TR10 is turned on and this will happen only if the number of clock pulses counted during a measurement exceeds 10. This circuit operates as follows:

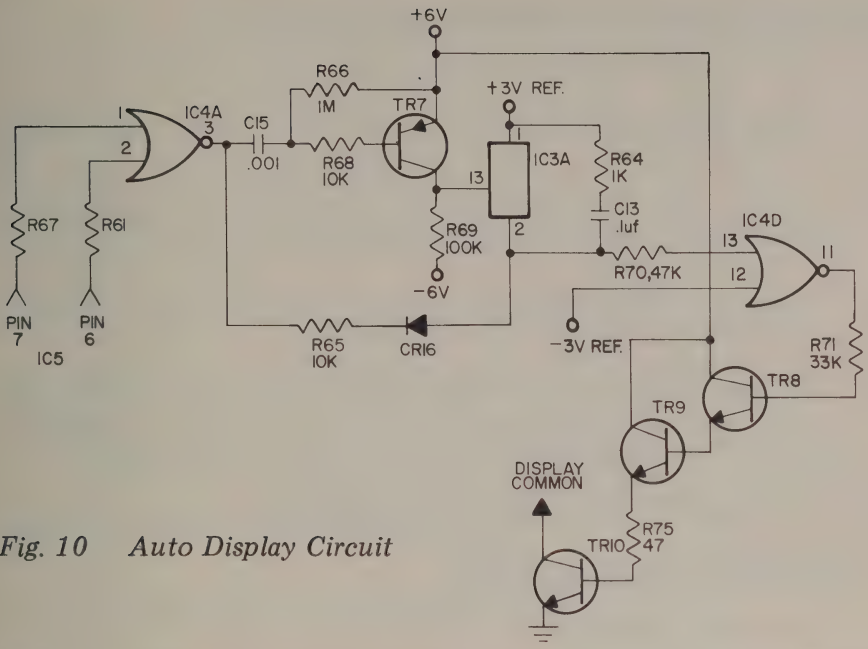

Fig. 10 Auto Display Circuit

The auto display circuit operates by means of a timed charge of C13 through CR16 and R65. When the measure cycle (ramp generation in the analog to digital converter) is started, either pin 1 or pin 2 of IC4A will be at a logic HI causing the output of this NOR gate to be at a logic LOW. A negative pulse of short duration is coupled to the base of TR7 closing the analog switch, IC3A, shorting out capacitor C13 allowing it to discharge and at the same time applying a HI to IC4D pin 13.

This causes a logic LOW at IC4D output turning off TR8, 9 and 10, for approximately 10 clock pulses. Now if the measure cycle is at least 10 clock pulses long, C13 will charge through CR16 and R65 to the logic LOW output of IC4A. This will allow a logic LOW at the input of IC4D, causing a logic HI at its output. The HI output of IC4D then turns on TR8, 9 and 10 to enable the segment drivers, which will allow a display. If the measure cycle is less than 10 clock pulses, C13 will not have enough time to charge and the displays will remain off.

If the OFF-AUTO-ON switch is placed in the ON position the segment drivers will receive a permanent ground and the display is on at all times even though the Auto Display circuit is still functioning.

DISASSEMBLY INSTRUCTIONS

To remove the panel assembly from the case proceed as follows:

1. Remove the battery cover by loosening the single thumb screw on the back.

2. Remove the two lower batteries and remove one Phillips head screw located behind each lower battery.

3. Grasp the case firmly in one hand and the panel in the other hand and seperate the panel from the case.

4. To reassemble, simply reverse the above procedure, being sure that the two plastic nuts mounted on the rear pc board are inserted into the screw posts on the inside of the case.

CALIBRATION INSTRUCTIONS

EQUIPMENT REQUIRED

1. Frequency Counter

2. .1% DC voltage source

3. .3% AC voltage source

4. Precision 1K, .1% resistor

CALIBRATION PROCEDURE

ZERO ADJUSTMENT

1. Place the OFF-AUTO-ON switch in the ON position. Select VOLTS DC function and 2V range.

2. Set the front panel zero adjust control to mid-range.

3. Adjust the coarse zero adjust control, R16, for a zero readout. Touch up the zero readout with the front panel zero adjust control if necessary.

CLOCK FREQUENCY ADJUSTMENT

1. Connect the common lead of the counter to the common lead of the DVM32.

2. Connect the counter input lead to the anode end of CR17.

3. Adjust R102 for a counter reading of 10KHz.

DC VOLTS CALIBRATION

1. Connect the two DVM32 input leads together and be certain the readout is zeroed.

2. Connect the DVM32 to a calibrated +1.0 volt source.

3. Adjust R99 to obtain a +1.000 readout on the DVM32.

4. Reverse the DVM32 input lead connections on the calibrated voltage source. Adjust R62 for a -1.000 readout on the DVM32.

AC VOLTAGE CALIBRATION

1. Connect the DVM32 input leads together and be sure the instrument is zeroed in the VOLTS DC function.

2. Set the Function switch to VOLTS AC and the range to 2V.

3. Adjust AC zero adjust, R30, for a zero readout.

4. Connect a calibrated 1.0VAC to the DVM32 input and adjust R9 for a 1.000 readout.

OHMS CALIBRATION

1. Set the Function switch to OHMS LOW POWER and the Range switch to 2K.

2. Connect the DVM32 input leads together and, if necessary, adjust the front panel ZERO adjust control for a zero readout.

3. Connect a 1K, .1% resistor to the input leads.

4. Adjust the Ohms Calibration adjustment, R36, for a 1.000 readout.

CALIBRATION IS NOW COMPLETE.

SERVICE AND WARRANTY

You have just purchased the finest Digital Multimeter on the market today. The Sencore DVM32 has been inspected and tested twice at the factory and has passed a rugged use test by our Quality Assurance Department to insure the best quality instrument to you. If something should happen, the DVM32 is covered by the Sencore Made Right guarantee as explained in the warranty policy enclosed with your instrument.

Sencore has six Regional Offices to serve you. Instruments to be serviced should be returned to the nearest Regional Office by UPS if possible. Parcel Post should only be used as a last resort. Instruments should be packed with the original packing materials or equivalent, and double boxed to insure safe arrival at the Regional Office. The display carton IS NOT an acceptable shipping container. When returning an instrument for service, be sure to state the nature of the problem to insure faster service.

If you wish to repair your own DVM32 Digital Multimeter, we have included a schematic and parts list. Any of these parts may be ordered directly from the Regional Office nearest you.

We reserve the right to examine defective components before an in warranty replacement is issued.

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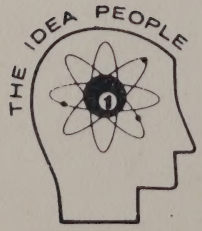

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